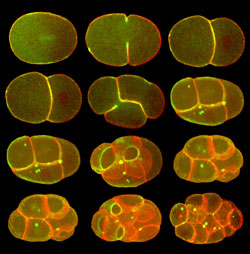
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**Cell Size Calculations Worksheet**

Ms. Ottolini



**Introductory Questions:**

1. What job does the cell membrane do for the cell?

It regulates the passage of materials into and out of the cell.

1. Why might it be a bad thing for the cell to have very little membrane?

It cannot move materials into and out of the cell efficiently.

Cell division in a worm embryo

**Your Task:**

Scientists compare the surface area of a cell (i.e. the amount of area the membrane covers on the outside of the cell) to its volume (i.e. the amount of 3D space inside the cell) to determine how efficiently the cell can move materials across its membrane. Below, you will use the following two equations to determine the surface area and volume of cube-shaped cells of various sizes. Using this method, we will determine how the surface area to volume ratio changes as the cell gets larger.

*Hint: A large surface area to volume ratio means there is a lot of membrane compared to the volume of the cell, which means the cell can transport materials very efficiently. A small surface area to volume ratio means there is very little membrane compared to the volume of the cell, which means the cell cannot transport materials efficiently.*

**Equations:**

|  |  |  |
| --- | --- | --- |
|  | **Surface Area of a Cube** | **Volume of a Cube** |
| **Equation** | SA = (l x w) x 6  (Note: l x w stands for the area of one side / face of the cube… for a cube, all six sides should have the same area, so you can multiply l x w by 6 to determine the total surface area of the cube) | V = l x w x h  (Note “l” stands for length, “w” stands for width, and “h” stands for height… for a cube, these measurements should all be the same) |
| **Sample Calculation** (for a cube with a side length of 1 cm) | SA = (1 cm x 1 cm) x 6 = 6 cm2 | V = 1 cm x 1 cm x 1 cm = 1 cm3 |

For the cube-shaped cell from the sample calculation, the surface area to volume ratio is 6 cm2 : 1 cm3, or simply 6:1. You always want to reduce the ratio so that the volume is 1. For our calculation above, we do not have to do this. However, let’s say that our surface area to volume ratio is 6:3. To reduce this ratio, we can divide both sides by 3, to give us a ratio of 2:1 (see calculation below)

|  |  |  |
| --- | --- | --- |
| **Original Ratio** | **Calculation** | **Reduced Ratio** |
| 6 cm2 : 3 cm3 |  | 2 cm2 : 1 cm3 |

We will be calculating the surface area to volume ratio for three cubes. The side lengths for these cubes are listed in the table on the next page. Show your surface area calculation, volume calculation, and “ratio reduction” calculation for each of these cubes in the appropriate columns. Then, answer the follow-up questions.

**Calculations Table:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cube** | **Picture and Side Length** | **Surface Area Calculation** | **Volume Calculation** | **Ratio Reduction Calculation** | **Final Surface Area to Volume Ratio** |
| Cube A | Side Length = 2 cm | (2 x 2) x 6 = 24 | 2 x 2 x 2 = 8 |  | 3 : 1 |
| Cube B | Side Length = 3 cm | (3 x 3) x 6 = 54 | 3 x 3 x 3 = 27 |  | 2 : 1 |
| Cube C | Side Length = 4 cm | (4 x 4) x 6 = 96 | 4 x 4 x 4 = 64 |  | 1.5 : 1 |

**Follow-Up Questions:**

1. What happens to the surface area to volume ratio as the size of the cube increases?

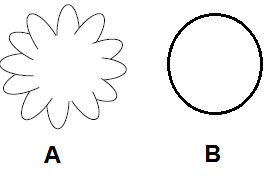
It decreases.

1. Which cell is able to transport materials most efficiently across its membrane—a small cell or a large cell?

A small cell because it has a higher SA:V (more membrane compared to the volume of the cell).

1. Use your answer to the previous two questions to provide support for the following statement: “Cells cannot grow forever. Eventually they have to divide.”

If cells grow to be too large, their SA:V is too low, resulting in inefficient transport of materials across the membrane. Therefore, they must divide to make two smaller cells.

1. Let’s say both cells shown below (A and B) have the same volume. Which cell will be able to transport materials most efficiently across its membrane? Explain your answer.

Cell A because it has a higher SA:V ratio due to the folds in its membrane.